Green Tea Benefits In Humans: A Review

Chi Thi Dao Vo*

* An Giang University, Vietnam National University Hochiminh City (VNU HCM).

Abstract:

After water, tea is the beverage that people drink the most worldwide. Caffeine, amino acids, and polyphenols are the main chemical constituents of green tea. (-)-epigallocatechin-3-gallate is the most prevalent catechin in green tea, which is rich in them. The natural phenol and antioxidant known as catechin are assumed to be the cause of many of the health advantages of green tea. It has been discovered that diets supplemented with many of these components of green tea, but especially with the diet combining caffeine and catechin, significantly reduced weight growth. According to recent human research, green tea may help lower the risk of cardiovascular disease and support other physiological processes like body weight control, an antioxidant-like impact, an anti-hypertensive effect, an effect on obesity, the effect of green tea on diabetes, and an effect on the liver. Green tea has been added to the list of beverages having functional qualities due to growing interest in its health benefits. The advantages and disadvantages of drinking tea are still up for debate, but the innumerable health benefits of tea much outweigh the few known harmful consequences.

Keywords: Green tea, green tea polyphenols, theophylline, caffeine, (-)-epigallocatechin-3-gallate (EGCG), antioxidant, obesity, blood pressure, liver. Diabetes.

Introduction

One of the most widely consumed drinks in the world is green tea. Tea, derived from the Camellia sinensis plant, is drunk as oolong, black, or green tea across the world. Out of all of them, drinking green tea has been shown to have the biggest impact on human health [1]. Originally from China, tea has been popular throughout the world in the last two millennia. Tea has an obvious economic and social benefit, and many people use it regularly as a daily beverage and as a medication for a variety of ailments. Teas can be divided into three main categories based on how they are made: "non-fermented" green tea, which is made by drying and steaming fresh leaves to inactivate the polyphenol oxidase and prevent oxidation); "semi-fermented" oolong tea, which is made by partially fermenting fresh leaves before drying; and "fermented" black and red teas, which go through a post-harvest fermentation stage before drying and steaming. While the fermentation of black tea is caused by oxidation that is catalyzed by polyphenol oxidase, the fermentation of red tea is achieved by using microorganisms [2] [3]. Over the past fifteen years, a great deal of research has been done on the health advantages of polyphenols contained in green tea, which is made from the unfermented leaves of the Camellia sinensis tea plant [4] [5]. An estimated 2.5 million tons of tea leaves are produced annually worldwide, of which 20% are used to make green tea. Recent studies have shown that drinking green tea has several health advantages, such as reducing the risk of cancer. The benefits of green tea and its separated constituents on cardiovascular diseases are anti-inflammatory, antiarthritic, antibacterial, antiangiogenic, antioxidant, antiviral, neuroprotective, and cholesterol-lowering are all being studied. But including green tea in the diet could also result in other dangerous health issues [6]. It has long been recognized that drinking tea, particularly green tea, provides health benefits for people. Because green tea extracts contain additional antioxidants, they are more stable than pure epigallocatechin gallate, one of the main ingredients of green tea. Herbal remedies are typically complicated blends of many substances that frequently work in concert to provide their maximum positive effects [7]. Numerous clinical and epidemiological investigations conducted in recent years have identified several physiological reactions to green tea that may be important for promoting health and preventing or treating certain chronic diseases. The findings of clinical

and epidemiological research on the connection between drinking green tea and human health, however, are not entirely consistent. For instance, inconsistent findings across human research may occur from failing to consider lifestyle and socioeconomic characteristics as well as from using insufficient methods to characterize the preparation and consumption of tea [3] [8]. Food is considered functional if it can be proved to affect one or more target functions in the body beneficially goes beyond adequate nutritional effects and is relevant to either the state of health and well-being or the reduction of disease risk. Green tea has been shown to have functional properties, and its consumption is currently highly recommended [9]. Green tea has long been associated with health advantages, but only recently, in fewer than thirty years have scientific studies on the beverage and its ingredients been conducted [3]. Investigations in animals and in vitro, as well as clinical trials using potential intermediaries. There is compelling evidence that green tea polyphenols (GTP) may be involved in the risk and pathophysiology of several chronic diseases, including cancer and cardiovascular disease, as well as associated pathologies. This is notably the case for biomarkers of oxidative stress state. Furthermore, several studies indicate that drinking green tea can help prevent kidney stones, dental cavities, cognitive decline, and low bone [10]. The purpose of this paper is to review the most current research on the health benefits of green tea and assess its possible relevance to diets.

Green tea composition

Green tea contains a complex mixture of amino acids (1-4%), including theanine or 5-N-ethylglutamine, glutamic acid, tryptophan, glycine, serine, aspartic acid, tyrosine, valine, leucine, arginine, and lysine, and proteins (15–20% dry weight), of which enzymes make up a significant portion. Calcium, magnesium, chromium, manganese, iron, copper, zinc, molybdenum, sodium, phosphorus, cobalt, strontium, nickel, potassium, fluorine, and aluminum are examples of carbohydrates (5–7% dry weight) along with pectins, glucose, fructose, and sucrose. Trace levels of vitamins B, C, and E, xanthic bases (theophylline, caffeine) (Figure 2.), pigments (carotenoids, chlorophyll), lipids (linoleic and α-linolenic acids), sterols (stigmasterol), and volatile chemicals (aldehydes, alcohols). The polyphenol content of green tea, especially the flavanols and flavonols that makeup 30% of the dry weight of fresh leaves, is primarily responsible for its health-promoting properties. Many of the above-noted health benefits of green tea have recently been linked to (-)-epigallocatechin-3-gallate (EGCG), the catechin that is most prevalent in it. Table 1 compares the average chemical composition of black tea leaves and their infusion to that of green tea leaves. Table 2 shows the flavonoid constituents of brewed green tea. As a result, green tea can be regarded as an essential dietary source of polyphenols, particularly flavonoids, which make up the most intriguing collection of components found in green tea leaves (Cabrera et al., 2006). With 50–80% of the total catechin content, epigallocatechin-3-gallate (EGCG) is the most prevalent catechin in green tea. It's regarded as the most bioactive part of green tea as well. Epigallocatechin (EGC), epicatechin, epicatechin-3-gallate (ECG), and catechins are other minor catechins [11]. The remaining solid components of green tea consist of caffeine, theanine, theaflavins, quercetin, and other phenolic compounds like chlorogenic acid and gallic acid. Green tea catechins are absorbed in the gut; yet, research shows significant subject-to-subject variation in the mechanism of absorption of these compounds. GTC from supplements has a higher bioavailability than brewed. Figure 1 shows the main catechin components of green tea polyphenols the main catechin components of green tea polyphenols [12] [13].

Table 1. The composition (%) of black tea, green tea, and black tea infusion [14]

Compound	Green Tea	Black tea	Infusion
Prtein	15	15	Trace
Amino acids	4	4	3.5
Fiber	26	26	0
Others carbohydrates	7	7	4
Lipids	7	7	Trace
Piqments	2	2	Trace
Minerals	5	5	4.5
Phenolic compounds	30	5	4.5
Oxidized phenolic compounds	0	25	4.6

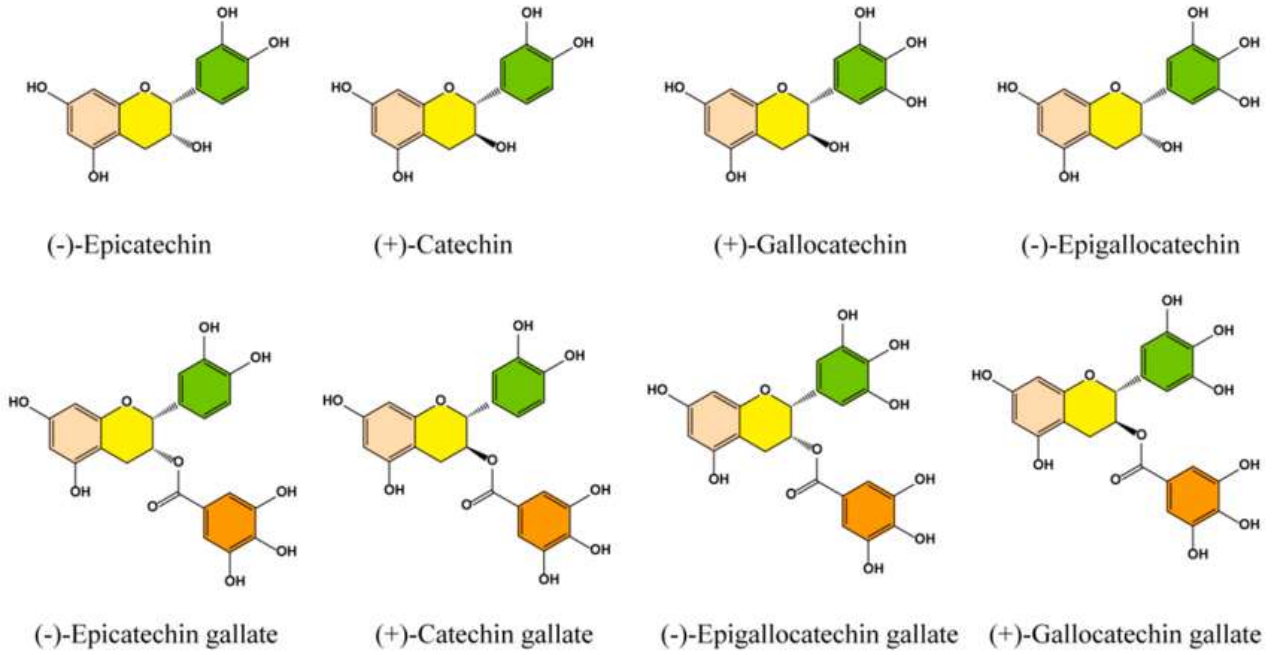

Figure 1. The main catechin components of green tea polyphenols [14]

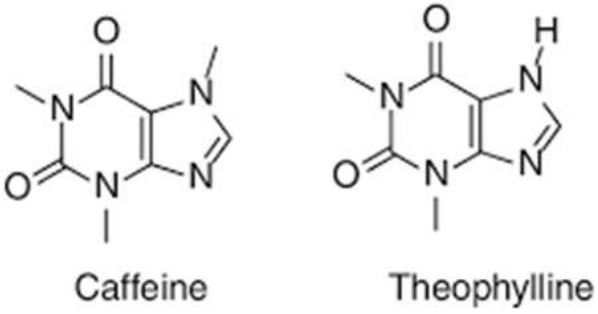

Figure 2. The chemical structure of caffeine and theophylline [15]

Table 2. Flavanoid constituents of brewed green tea [16]

Constituents	Concentration (mg/100 g)
Epigallocatechin 3-gallate	77.8 ± 7.0
Epicatechin 3-gallate	19.7 ± 2.8
Epigallocatechin	16.7 ± 1.4
Epicatechin	8.3 ± 0.5
Quercetin	2.7 ± 0.3
Catechin	2.6 ± 1.5
Gallocatechin	1.5 ± 0.0
Thiarubigins	1.1 ± 1.1
Theaflavin	0.1 ± 0.0
Total flavonoids	130.5

Green tea production method

To avoid fermentation and produce a stable and dry tea, recently collected leaves are steamed right away. Tea retains its green color during the rolling and drying operations because the enzymes that break down the color pigments in the leaves are destroyed during the steaming process. In terms of their potential to promote health, these procedures maintain natural polyphenols [17].

Green tea's pharmacological importance

Since ancient times, green tea has been regarded as both a medicinal and beneficial beverage. This plant is suggested by traditional Chinese medicine to treat headaches, aches, and pains in the body, depression, digestion, detoxification, and general life prolongation [13]. Recently, green tea has gained a lot of attention for its numerous health advantages for a range of illnesses, from cancer to weight loss, in both the scientific and consumer worlds. The most well-known characteristic of green tea and its constituent catechins is their antioxidant capacity, which has led to their investigation into a variety of diseases linked to reactive oxygen species (ROS), including cancer, cardiovascular, and neurological disorders [18]. Recent epidemiological data and extensive laboratory studies have demonstrated that tea's polyphenolic components may lower the incidence of several diseases [1].

A possible antioxidant

Free radicals are chemical entities with unpaired electrons that are often exceedingly reactive and can be thought of as pieces of molecules. The natural results of several biological activities that occur both inside and between cells are called free radicals. When healthy cells are attacked by free radicals, their cytoplasm is released, exposing them to mutations, genetic damage, and infection. It is well known that antioxidants scavenge these free radicals, shielding the body from the damaging effects of dangerous illnesses [19]. Antioxidants, which include singlet oxygen, superoxide, peroxyl radicals, hydroxyl radicals, and peroxynitrite, are substances that shield cells from the harmful effects of reactive oxygen species. Oxidative stress is brought on by an unbalanced intake of antioxidants and reactive oxygen species, which damages cells [20]. Catechins are potent antioxidants both in vivo and in vitro. Green tea's antioxidant capacity is further enhanced by the presence of specific minerals and vitamins in it. Green tea catechins boost overall plasma antioxidant activity, according to in vivo research. Catechins are thought to aid in the prevention of these illnesses by strengthening the overall antioxidant defense system in conjunction with antioxidant vitamins (such as vitamins C and E) and enzymes (such as catalase and superoxide dismutase) [21] [22].

Effect on Obesity

Overweight and obesity are fast-increasing medical conditions that are recognized as threats to the health of many people in developed nations. Numerous illnesses, such as hypertension, non-insulin-dependent diabetes, pulmonary dysfunction, osteoarthritis, and several forms of cancer, are significantly influenced by obesity [23]. A green tea extract's potent caffeine content did not fully explain how much it increased brown adipose tissue thermogenesis. Instead, the extract's thermogenic qualities may be primarily derived from the way that caffeine's high catechin-polyphenol content interacts with sympathetically released noradrenaline. Tea catechins, particularly EGCG (-epigallocatechin-3-gallate), seem to have antidiabetic and anti-obesity properties. The health advantages of EGCG on obesity and diabetes have not been demonstrated by much epidemiological or clinical research, but a variety of laboratory data is beginning to reveal the processes underlying its activities. These mechanisms could be linked to specific pathways, like changes in food consumption, lipid and carbohydrate metabolism, endocrine systems, energy balance, and redox status [24].

Effect on blood pressure

Hypertension is characterized by a persistent systolic blood pressure over 140 mmHg or a persistent diastolic blood pressure above 90 mmHg. Increased peripheral vascular smooth muscle tone causes elevated arteriolar resistance and decreased venous capacitance, ultimately leading to hypertension. Chronic hypertension, whether systolic or diastolic, can cause kidney damage, congestive heart failure, myocardial infarction, and cerebrovascular accidents (strokes), even though many of these people show no symptoms. When hypertension is identified early and treated appropriately, the rate of morbidity and death is greatly reduced [25]. Triglycerides, HDL cholesterol, and diastolic blood pressure do not significantly change after drinking green tea. Gender-specific between-group comparisons showed that the effect of green tea on total cholesterol reduction was substantially higher in men and significantly greater in women for LDL cholesterol reduction. Green tea was more effective in lowering systolic blood pressure and LDL cholesterol in normolipidemic than in dyslipidemic when it came to lowering total cholesterol [26]. Meta-analyses derived from observational research demonstrated a noteworthy inverse correlation between green tea and cardiovascular conditions such as myocardial infarction, stroke, and coronary artery disease. The development of hypertension is largely dependent on obesity, which also raises the morbidity and death rates related to the condition in the cardiovascular system. This is supported by well-established research [27].

Effect of green tea on diabetes

Currently, one of the biggest global public health issues is diabetes mellitus. Over the previous three decades, the number of persons worldwide who have diabetes mellitus has more than doubled. Furthermore, it is anticipated that by 2030, this figure will have increased to 439 million, or 7.7% of the world's adult population between the ages of 20 and 79 [28]. The five main lifestyle factors of food, physical activity, smoking, obesity, and alcohol use account for over 90% of incidence occurrences of type 2 diabetes mellitus. People who have trouble with glucose tolerance or fasting glucose are typically thought to have a higher chance of getting type 2 diabetes in the future [29] [30]. Phosphoenolpyruvate carboxykinase, a glucose-producing enzyme, is less expressed in genes when (-)-epigallocatechin-3-gallate (EGCG) mimics insulin and enhances the tyrosine phosphorylation of the insulin receptor and its substrate. On the other hand, EGCG acts on many insulin-activated kinases with slower kinetics than insulin. These results suggested a possible function for EGCG or its derivatives as an anti-diabetic drug and showed that modifications in the redox state may be advantageous for the treatment of diabetes [31]. Green tea has been shown to have the most significant health benefits of any tea, and this is primarily because of its catechins, which are members of the flavonoid-like polyphenols, or flavanols, family of chemicals. The most prevalent catechins in green tea extract are flavonols,

specifically epicatechin gallate (EGCG), epicatechin, epigallocatechin, and epicatechin [16]. According to Lambert et al. [32], EGCG administered intragastrically at a dose of 75 mg/kg produced a terminal half-life of 83 minutes and a Cmax of 128 mg/l total plasma EGCG. Additionally, EGCG had a terminal half-life of 112 minutes and a Cmax of 130 mg/l total plasma EGCG in humans who took it orally at a dose of 50 mg (0.7 mg/kg). Based on these findings, rodents need to be given 100–600 times more EGCG orally (depending on if they are given by feed admixture or gavage) to reach plasma concentrations comparable to those in people. Humans can consume low to moderate dosages of EGCG to achieve total plasma EGCG concentrations that have been demonstrated to be effective in mice and rats [33]. Green tea has been shown to dramatically lower Hb A_{1c} and fasting glucose concentrations. It may also lower fasting insulin concentrations. To assess and validate these results further, more long-term, high-quality RCTs (randomized controlled trials) that are especially intended to assess the effects of green tea on insulin sensitivity and glucose management are required [34].

Effect on liver

One of the primary metabolic organs in the body, the liver is involved in the production and breakdown of important biological substances like lipids, proteins, and carbohydrates. A rising number of liver illnesses, including fatty liver, liver cirrhosis, and hepatocellular carcinoma (HCC), have also been observed in recent decades. Remarkably, primary hepatic malignancies are the sixth most common cancer globally and the third largest cause of cancer-related deaths. HCC is the most common type of primary liver malignancy [35]. Some studies show that drinking green tea can lower the risk of liver disease. Consuming green tea has been linked to a lower incidence of hepatitis, liver cirrhosis, HCC, fatty liver disease, and chronic illness. Drinking green tea significantly reduces the risk of liver disorders. Long-term tea catechin intake may protect against obesity and type II diabetes brought on by high-fat diets, as well as lower the risk of coronary heart disease [36].

Adverse effects of green tea

Although green tea's health advantages are immense, more research is still needed to fully understand why it poses a risk to human health. The presence of aluminum, the high concentration of caffeine in tea, and the impact of tea PPs (tea polyphenols) on iron bioavailability are the three main causes of the harmful effects of excessive tea drinking, whether it be green. Furthermore, not every person will get the same benefits from green tea catechins. Higher consumption of green tea can cause acute cytotoxicity in liver cells, a key organ involved in metabolism. This is because green tea extract contains EGCG, which is cytotoxic [37]. Similar to coffee, a day's worth of green tea consumption enhances the cognitive and psychomotor abilities of healthy people. However, because green tea has less caffeine than coffee, it is less likely to interfere with nighttime sleep than coffee [2]. The following sequence shows the caffeine level of teas that are the same in kind but are produced using different fermentation processes: black tea > oolong tea > green tea > fresh tea leaf. Green tea has a low caffeine level, but if you have a particular sensitivity to xanthic bases, it is not advised to consume it. Theophylline, a stimulant that belongs to the xanthine family, has negative effects that are comparable to those of caffeine, but they only manifest when large doses are used. Therefore, people with serious circulatory issues or cardiac disorders should avoid drinking green tea. Women who are nursing or pregnant should limit their daily intake to 1-2 cups since it may affect their heart rate. Because green tea has diuretic properties, it is also advised to limit the amount of green tea used concurrently with some medications [13].

Conclusion

One of the most widely consumed drinks in the world is green tea. Tea is a safe, affordable, widely enjoyed, and socially acceptable beverage that was first used as a medication. It has since

evolved into a popular beverage and has the potential to become a significant raw resource in the industrial and pharmaceutical industries. Research indicates that tea has a wide range of phytochemicals that the body may absorb, digest, and metabolize. Additionally, the components in tea have an impact at the cellular level. The fact that tea is a functional food lends legitimacy to the centuries-old ideas held by tea consumers. Based on observational research, there is a considerable decrease in the incidence of hypertension and stroke, suggesting that regular drinking of green tea may have preventive effects on the cardiovascular system. Weight control, anti-cancer, antioxidant, anti-diabetic, anti-hypertensive, and other properties are all possessed by green tea polyphenols, particularly EGCG. However, significant clinical data about green tea chemicals' bioavailability, safe dose, and mechanisms of action in many diseases must be investigated before using them to treat diseases.

References

[1] Cabrera C, Artacho R, Giménez R, "Beneficial effects of green tea: a review," *J Am Coll Nutr,* vol. 25, p. 79–99, 2006.

[2] KC, Willson, "Coffee, Cocoa and Tea," *New York: CABI Publishing,* 1999.

[3] McKay DL, Blumberg JB, "The role of tea in human health: An update," *J Am Coll Nutr,* vol. 21, p. 1–13, 2002.

[4] Dulloo AG, Duret C, Rohrer D, Girardier L, Mensi N, Fathi M, et al., "Efficacy of a green tea extract rich in catechin polyphenols and caffeine in increasing 24-h energy expenditure and fat oxidation in humans," *Am J Clin Nutr.,* vol. 70, pp. 1040-50, 1999.

[5] Venables MC, Hulston CJ, Cox HR, Jeukendrup AE, "Green tea extract ingestion, fat oxidation, and glucose tolerance in healthy humans," *Am J Clin Nutr,* vol. 87, p. 778–84., 2006.

[6] Venables MC, Hulston CJ, Cox HR, Jeukendrup AE, "A new function of green tea: prevention of lifestyle related diseases," *Ann N Y Acad Sci 2001, 928:274-280.,* vol. 928, pp. 274-280., 2001.

[7] Osada K, Takahashi M, Hoshina S, Nakamura M, Nakamura S, Sugano M, "Tea catechins inhibit cholesterol oxidation accompanying oxidation of low density lipoprotein in vitro," *Comp Biochem Physiol Part C Toxicol Pharmacol,* vol. 128, pp. 153-164., 2021.

[8] Il'yasova D, Martı ´n C, Sandler RS, "Tea intake and risk of colon cancer in African-Americans and Whites: North Carolina colon cancer study," *Cancer Causes Control ,* vol. 14, p. 676–772, 2003.

[9] Diplock AT, Aggett PJ, Ashwell M, Bornet F, Fern EB, Rober- froid MB, "Scientific concepts of functional foods in Europe consensus document," *Br J Nutr ,* vol. 81, p. 1–27, 1999.

[10] Wu CD, Wei GX, "Tea as a functional food for oral health," *Nutrition,* vol. 18, pp. 443–444,, 2002.

[11] USDA, "USDA Database for the Flavonoid Contents of Selected Foods," *Beltsville: US Department of Agriculture,* 2003.

[12] Rains TM, Agarwal S, Makia KC, "Antiobesity effects of green tea catechins: a mechanistic review," *J Nutri Biochem 22:1–7,* p. 1–7, 2011.

[13] Cabrera C, Artacho R, Gime´nez R, "Beneficial effects of green tea—a review," *J Am Coll Nutr 25:79–99,* vol. 25, p. 79–99, 2006.

[14] Belitz DH, Grosch W, "Quı'mica de los Alimentos Zaragoza," *Acribia ,* 1997.

[15] Bansal, Sumit, "Pharmacological profile of green tea and its polyphenols: A review," *Medicinal Chemistry Research ,* vol. 21, no. 11, 2011.

[16] USDA, "Database for the Flavonoid Content of Selected Foods. Nutrient Data Laboratory. Food Composition Laboratory. Beltsville Human Nutrition Research Center. Nutrient Data Laboratory," *United States Department of Agriculture. Available at:http://www.ars.usda.gov/SP2UserFiles/Place/12354500/Data/Flav/Flav02-1.pdf. Accessed February 20, 2011,* Accessed February 20, 2011.

[17] Chacko SM, Thambi PT, Kuttan R, Nishigaki, "Beneficial effects of green tea: a literature review. Chin Med 5:13," *Chin Med,* p. 5:13, 2010.

[18] NT, Zaveri, "Zaveri NT (2006) Green tea and its polyphenolic catechins: Medicinal uses in cancer and noncancer applications," *Life Sci ,* vol. 78, p. 2073–2080, 2006.

[19] Young IS, Woodside JV, "Antioxidants in health and disease," *J Clin Pathol,* vol. 54, p. 176–186 , 2001.

[20] Halliwell B, Gutteridge JMC, "Free Radicals in Biology and Medicine," *Oxford: Clarendon Press,* 1985.

[21] Yokozawa T, Nakagawa T, Kitani K, "Antioxidative activity of green tea polyphenol in cholesterol-fed rats," *J Agric Food Chem.,* vol. 50, p. 3549–3552, 2002.

[22] Abdel-Raheim MAM, Enas AH, Khaled AE, "Effect of green tea extract and vitamin c on oxidant or antioxidant," *Indian J Clin Biochem,* vol. 29, p. 280–287, 2009.

[23] H., Noppa, "Body weight change in relation to incidence of ischemic heart disease and change in risk factors for ischemic heart disease," *American Journal of Epidemiology,* vol. 111, p. 693–704, 1980.

[24] Yang MH, Wang CH, Chen HL Yang MH, Wang CH, Chen HL, "Green, oolong and black tea extracts modulate lipid metabolism in hyperlipidemia rats fed high-sucrose diet," *J Nutr Biochem,* vol. 12, pp. 14-20, 2001.

[25] Sumit Bansal, Navneet Syan, Pooja Mathur, Shivani Choudhary, "Pharmacological profile of green tea and its polyphenols: a review," *Med Chem Res,* 2011.

[26] Taubert D, Roesen R, Schömig E, "Effect of cocoa and tea intake on Blood Pressure," *Arch Intern Med.,* vol. 16, no. 7, pp. 626-634, 2007.

[27] Mikhail N, Golub MS, Tuck ML, "Obesity and hypertension Prog Cardiovasc Dis," *PubMed,* vol. 42, pp. 39-58, 1999.

[28] Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, Lin JK, Farzadfar F, Khang YH, Stevens GA, et al., "National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: systematic analysis of health examination surveys and epidemiological studies with 370 country-years and 2.7 million participants," *Lancet,* vol. 378, p. 31–40, 2011.

[29] Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, Solomon CG, Willett WC, "Diet, lifestyle, and the risk of type 2 diabetes mellitus in women," *N Engl J Med ,* vol. 345, p. 790–7., 2001.

[30] Lindstro¨m J, Peltonen M, Eriksson JG, Aunola S, Hamalainen H, Ilanne-Parikka P, Keinanen-Kiukaanniemi S, Uusitupa M, Tuomilehto J, "Determinants for the effectiveness of lifestyle intervention in the Finnish Diabetes Prevention Study," *Diabetes Care,* vol. 31, p. 857–62, 2008.

[31] Waltner-Law ME, Wang XL, Law BK, Hall RK, Nawano M, Granner DK, "Epigallocatechin gallate, a constituent of green tea represses hepatic glucose production," *J Biol Chem ,* vol. 277, p. 34933–34940, 2002.

[32] Lambert JD, Lee MJ, Lu H, Meng X, Hong JJJ, Seril DN, Sturgill MG, Yang CS, "Epigallocatechin-3-gallate is absorbed but extensively glucuronidated following oral administration to mice," *J Nutr,* vol. 133., no. 12, pp. 4172-7., 2003.

[33] Sabu M Chacko, Priya T Thambi, Ramadasan Kuttan, Ikuo Nishigaki, "Beneficial effects of green tea: A literature review," *Chinese Medicine ,* p. 5:13, 2010.

[34] Kai Liu, Rui Zhou, Bin Wang, Ka Chen, Lin-Ying Shi, Jun-Dong Zhu, and Man-Tian Mi, "Effect of green tea on glucose control and insulin sensitivity: a meta-analysis of 17 randomized controlled trials1–3," *Am J Clin Nutr ,* vol. 98, p. 340–8, 2013.

[35] Li Y, Chang SC, Goldstein BY, Scheider WL, Cai L, You NC, Tarleton HP, Ding B, Zhao J, Wu M, Jiang Q, Yu S, Rao J, Lu QY, Zhang ZF, Mu L, "Green tea consumption, inflammation and the risk of primary hepatocellular carcinoma in a Chinese population," *Cancer Epidemiol,* vol. 35, pp. 362-368, 2011.

[36] Yin X, Yang J, Li T, et al., "The effect of green tea intake on risk of liver disease: a meta analysis," *International Journal of Clinical and Experimental Medicine,* vol. 8, no. 6, pp. 8339-8346, 2015.

[37] Schmidt M, Schmitz HJ, Baumgart A, Guedon D, Netsch MI, Kreuter MH, Schmidlin CB, Schrenk D, "Toxicity of green tea extracts and their constituents in rat hepatocytes in primary culture," *Food Chem Toxicol,* vol. 43, pp. 307-314, 2005.